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Patents Form 1/77

Request for grant of a patent

1.	Your Reference	**PLB/CC/W151**
2.	Application number	**0204928.6** 01 MAR 2002
3.	Full name, address and postcode of the or each Applicant Country/state of incorporation (if applicable)	**Per-Tec Limited** **Manchester School of Engineering** **The University of Manchester** **Simon Building** **Oxford Road** 5093106001 **Manchester M13 9PL** **Incorporated in: England & Wales**
4.	Title of the invention	**Improvements In and Relating to Apparatus for Removing Pollutants from Gas Streams**
5.	Name of agent Address for service in the UK to which all correspondence should be sent Patents ADP number	**APPLEYARD LEES** **15 CLARE ROAD** **HALIFAX** **HX1 2HY** **190001** ✓

6. Priority claimed to:

Country	Application number	Date of filing

7. Divisional status claimed from:

Number of parent application	Date of filing
-	-

8. Is a statement of inventorship and of right to grant a patent required in support of this application? **YES**

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	**11 x 2**
Claim(s)	CE
Abstract	
Drawing(s)	**6 x 2**

10. If you are also filing any of the following, state how many against each item

Priority documents	
Translation of priority documents	
Statement of inventorship and right to grant a patent (PF 7/77)	
Request for a preliminary examination and search (PF 9/77)	
Request for substantive examination (PF 10/77)	
Any other documents (please specify)	

11. We request the grant of a patent on the basis of this application.

Signature: **APPLEYARD LEES** Date: **28 February 2002**

Appleyard Lees

12. Contact **Paul Brandon – 0161 835 9655**

FIGURE 1

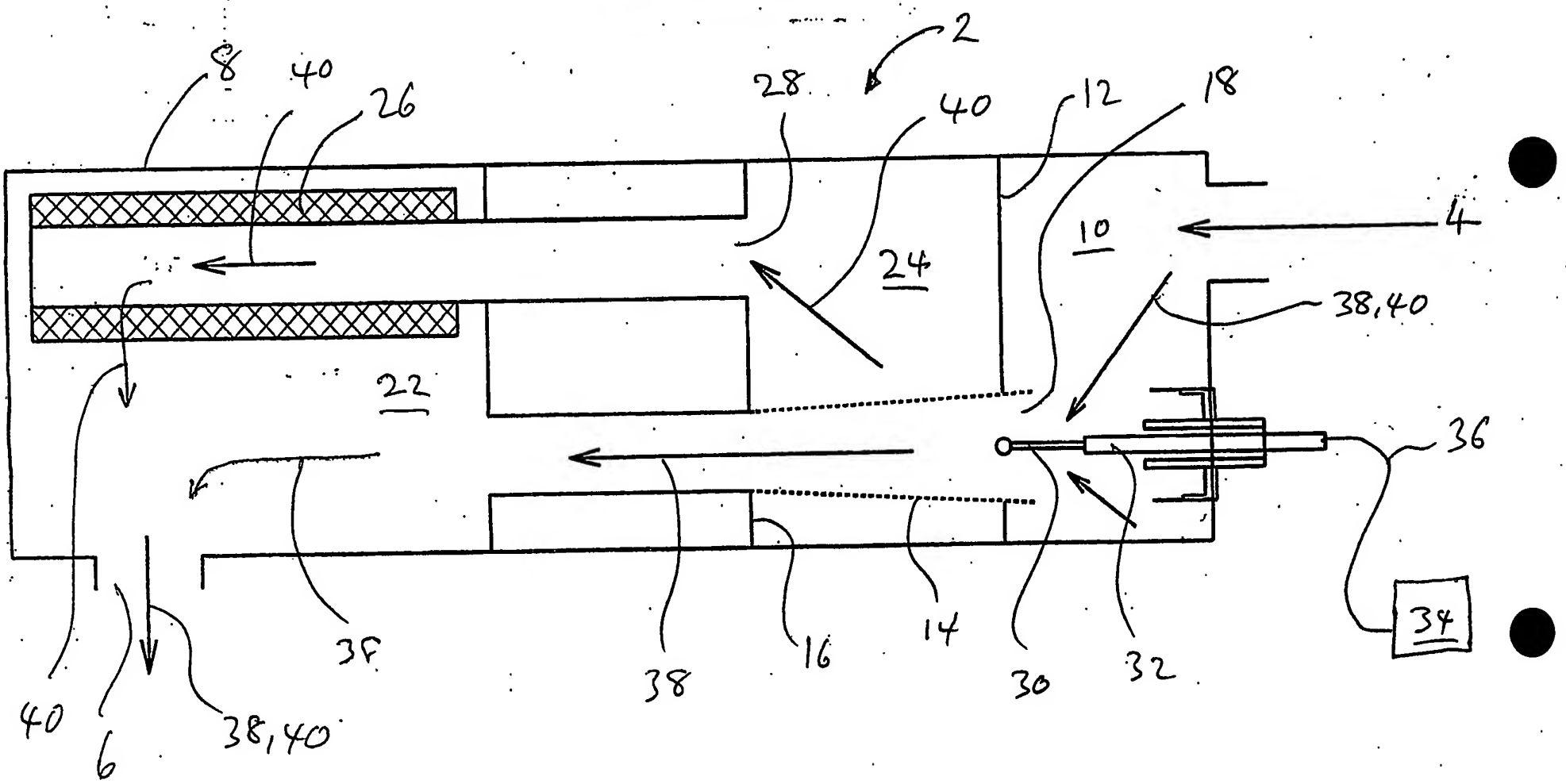


Fig 2

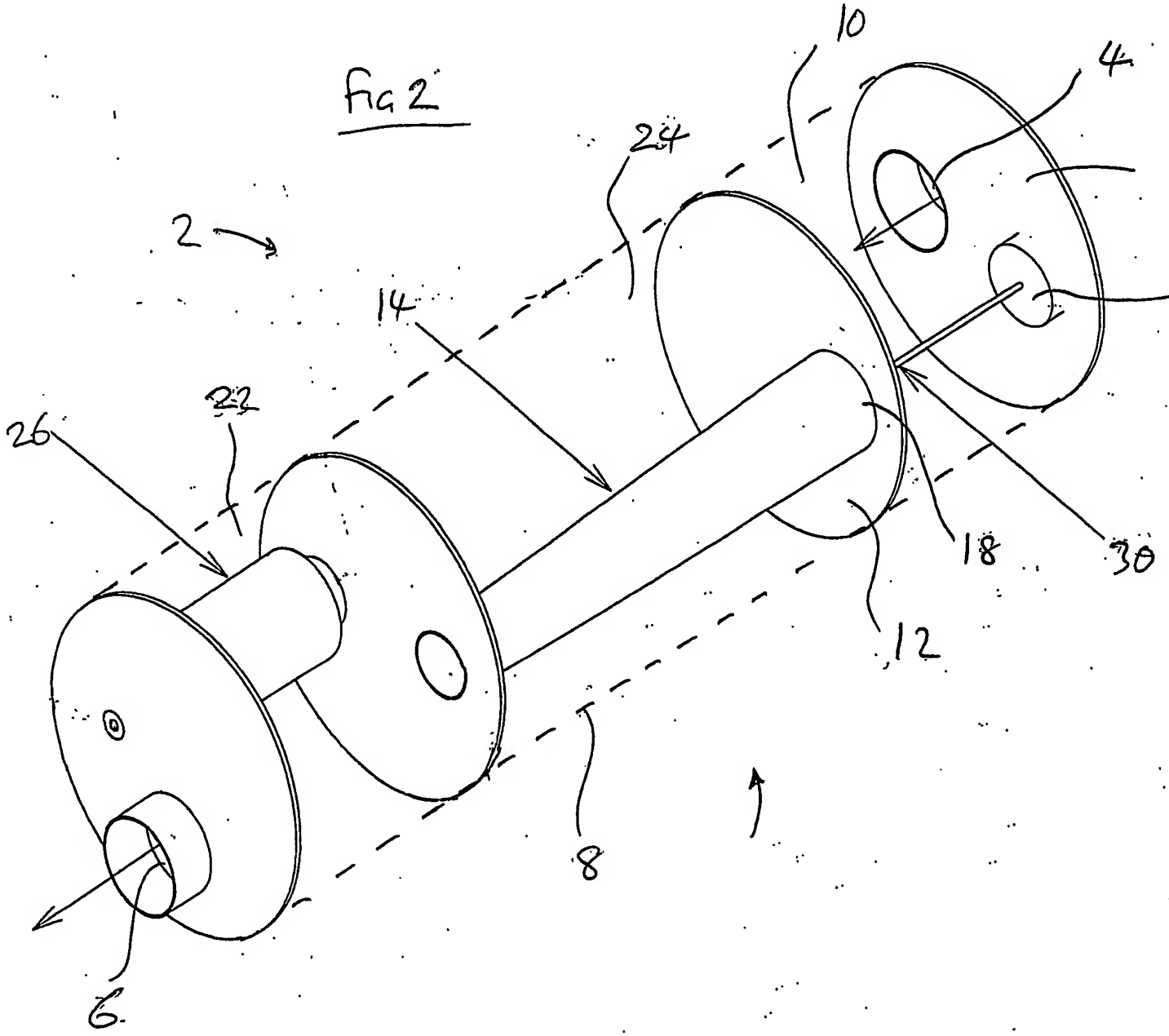


FIGURE 3

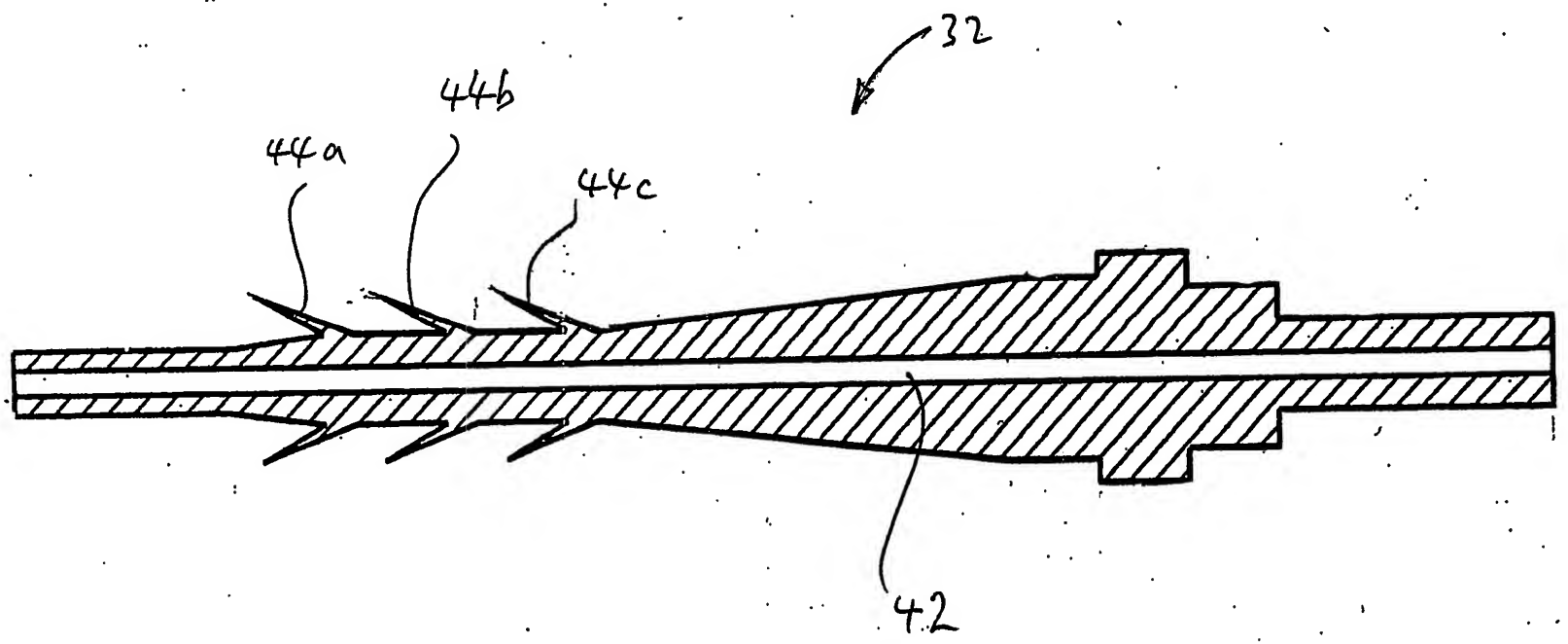


FIGURE 4

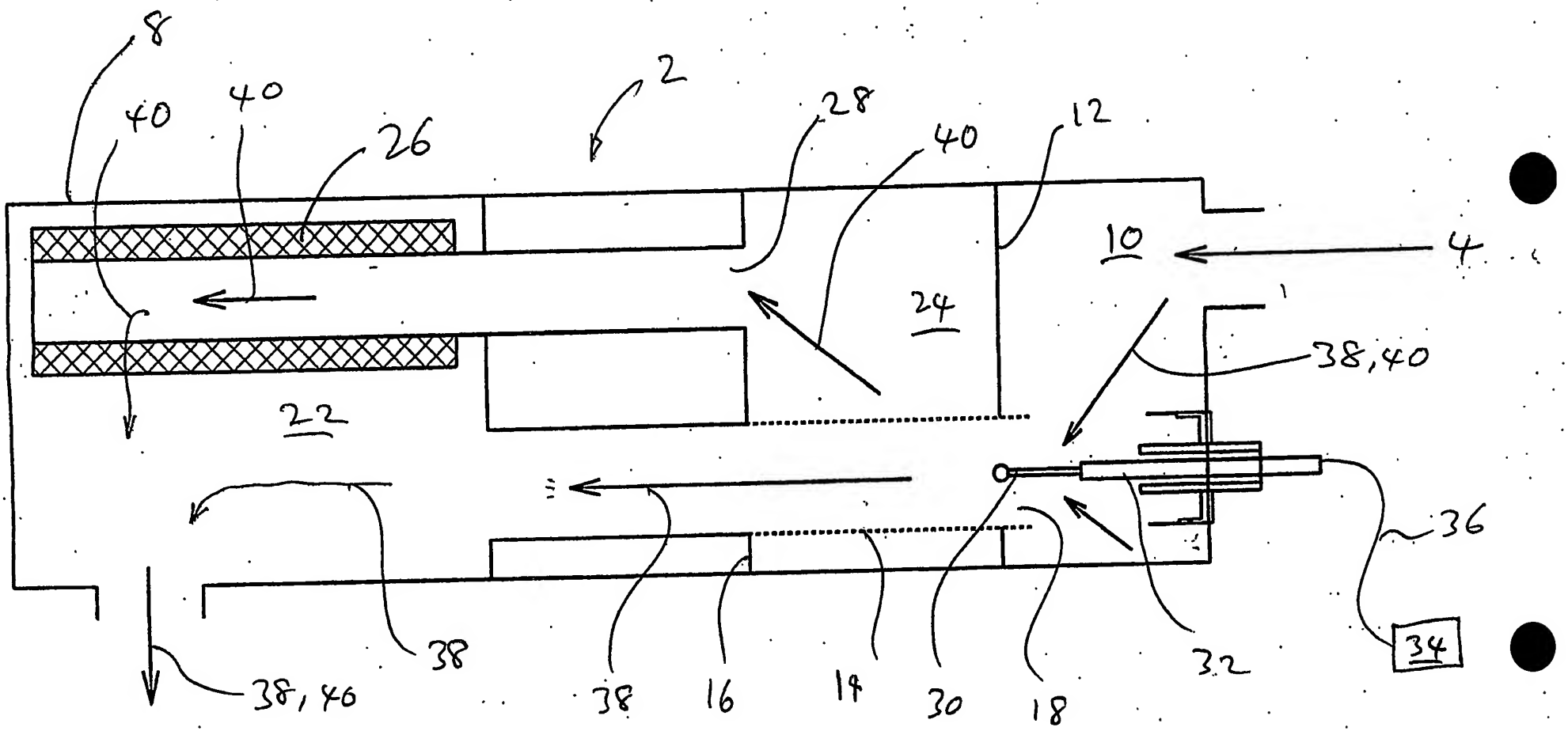


FIGURE 5

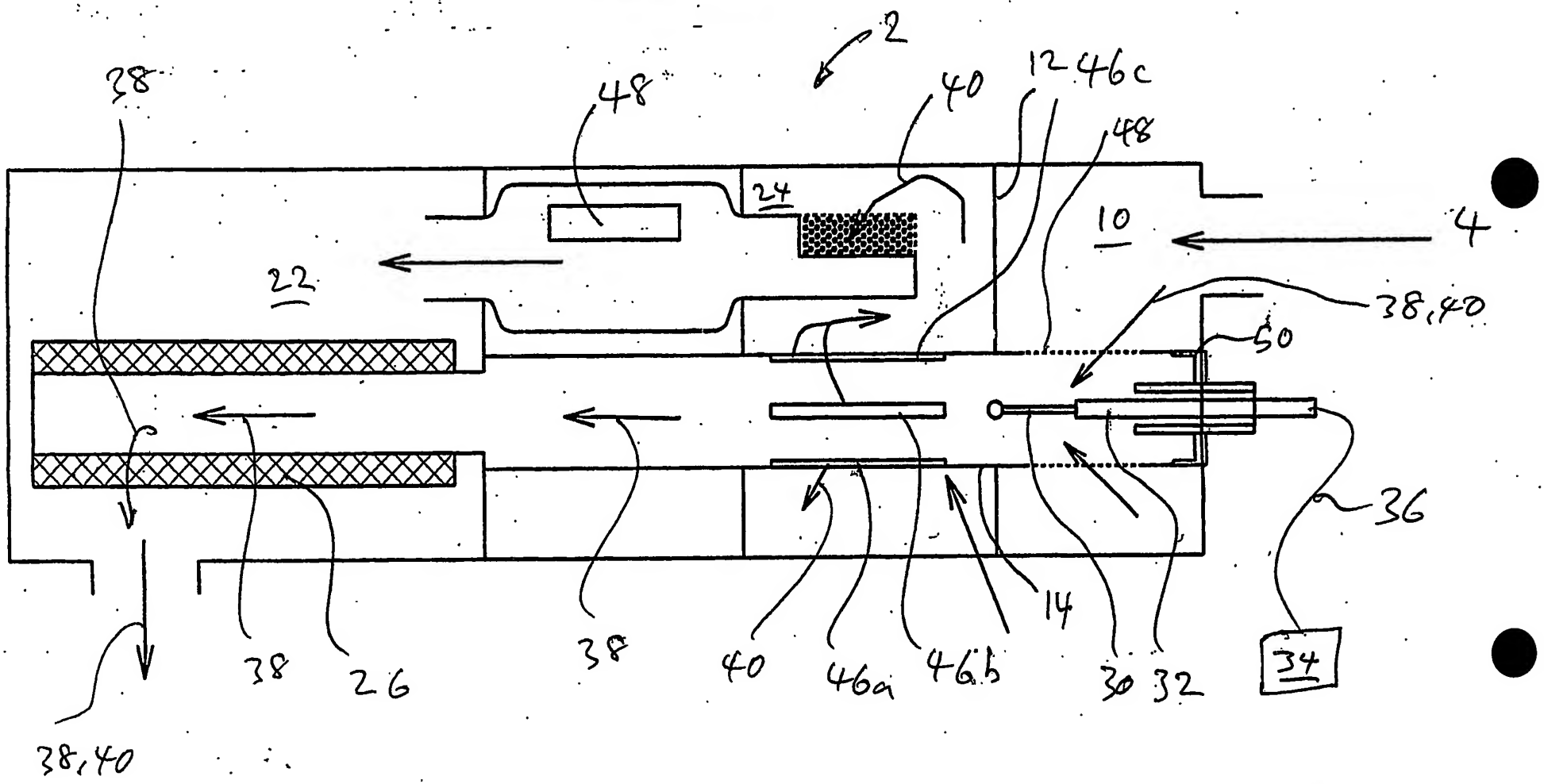
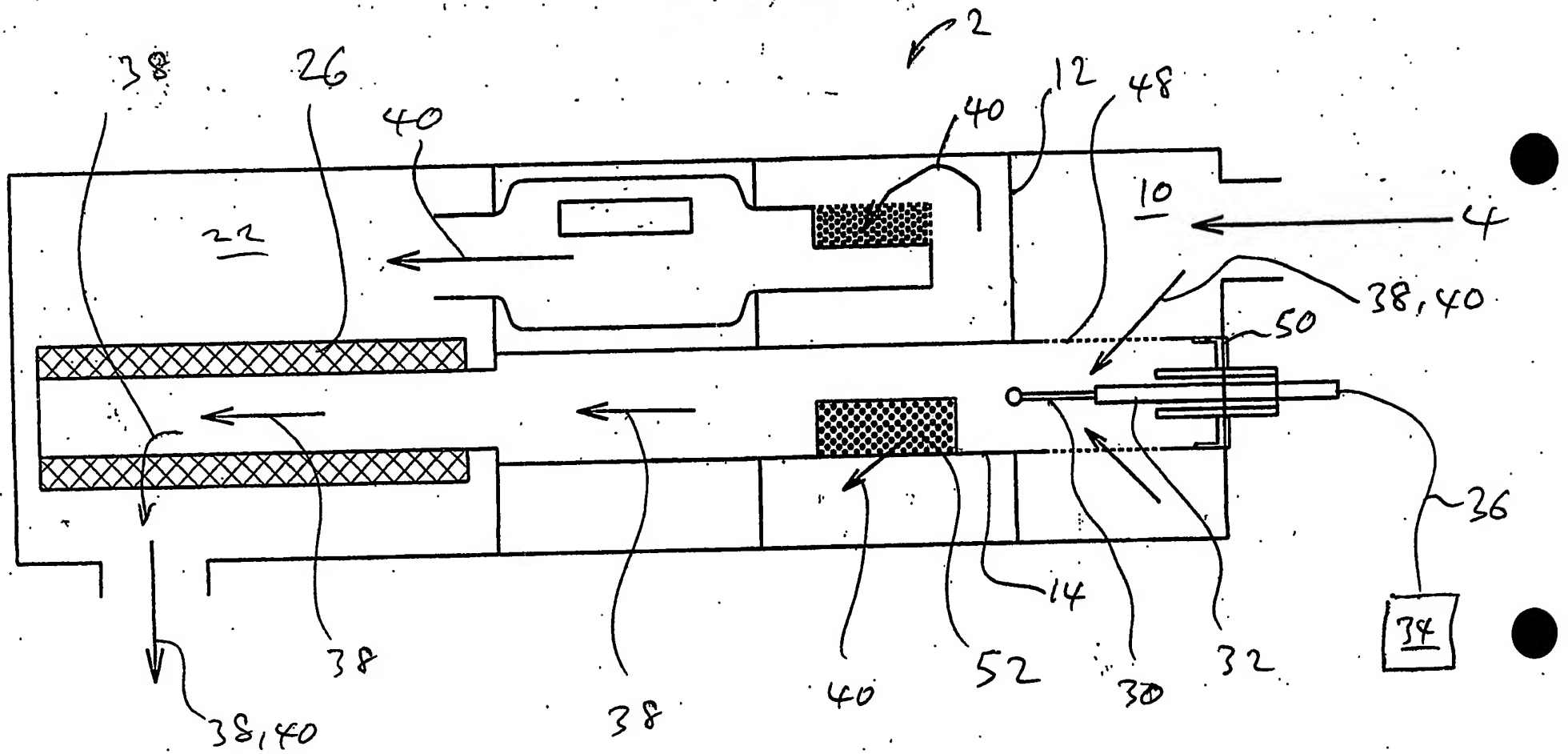

2
38
48
40
12
46c
48
24
10
4
22
38,40
50
36
14
38
26
38
40
46a
46b
30
32
34
38,40

FIGURE 6



IMPROVEMENTS IN AND RELATING TO APPARATUS FOR REMOVING POLLUTANTS FROM GAS STREAMS

Field of the Invention

The present invention relates to apparatus for removing pollutants from gas streams.

Background of the Invention

Pressure is continuing to grow on vehicle manufacturers to reduce the amount of pollutants, especially particulates in gas streams emitted from vehicle exhausts. Attempts have been made to collect particulates from gas streams using electro-static precipitation, but generally these fail because the performance of the apparatus degrades substantially over time so it cannot be used in a practical environment.

One particular problem area is in relation to the particulate material that is agglomerated. For instance, in a prior art electro-static precipitation apparatus of this type, a central electrode is mounted within a circular cylindrical solid-walled tube, whereby particulates are charged by the electrode and attracted to the solid-walled container. However, once particulates arrive at the tube wall over time they agglomerate and can eventually be swept out through the vehicle exhaust by the continued flow of exhaust gas flow stream over the agglomerated particulate.

In other prior art devices filters have been proposed to remove particulates from gas streams. However, in this

case over time particulate build up in the filters reduces their efficiency and causes back-pressure reducing engine efficiency also.

It is an aim of preferred embodiments of the present invention to obviate or overcome a disadvantage of the prior art, whether referred to herein or otherwise.

Summary of the Invention

According to the present invention in the first aspect, there is provided an apparatus for removing pollutants from a gas stream, the apparatus comprising means for charging particulates in the gas stream and a tube through which the gas stream at least partly flows, whereby the tube is at least partly porous to the gas stream and the apparatus additionally comprises means for collecting at least one pollutant.

Suitably, the tube is at least partly about the charging means. Suitably, the charging means comprises an electrode.

Suitably, the tube is perforated. Suitably, the tube comprises a plurality of holes therethrough. Suitably, the holes are evenly spaced. Suitably, the holes are evenly sized. Suitably, the perforated region of the tube is substantially annular. Suitably, the perforated region of the tube extends for a substantial length thereof.

Suitably, the tube comprises at least one slot therethrough. Suitably, a plurality of slots is provided. Suitably, the slots are substantially evenly distributed

about the tube. Suitably, the at least one slot runs longitudinally along the tube.

Suitably, a major portion of the tube is porous. Alternatively a minor portion of the tube is porous.

Suitably, the tube is circular in cross-section. Suitably, the tube comprises an inlet and an outlet.

Suitably, the cross-sectional area of the tube decreases along its length from the input to the output thereof.

Suitably, the electrode is mounted at one end thereof only.

Suitably, there is a first gas flow path from an apparatus gas inlet to an apparatus gas outlet and a second gas flow path from the apparatus gas inlet to the apparatus gas outlet. The first and second gas flow paths may be in common for a part thereof. Suitably, a filter is located in the second gas flow path. Suitably, the tube is located in the first and second gas flow paths. The tube acts to split the gas flows and concentrate at least one pollutant in one flow path for subsequent removal.

Suitably, the apparatus comprises a first expansion tube in fluid communication with an apparatus gas inlet. Suitably, the diverting tube extends from the first expansion tube to a second expansion tube defined by the tube. Suitably, there is a third expansion tube about the diverting tube into which gas can flow through the diverting tube. Suitably, a filter is located between (in respect of gas flow) the second and third expansion tubes.

Suitably, the filter comprises an electrically regenerative filter.

Suitably, the apparatus is for removing pollutants from an exhaust gas stream, preferably a vehicle exhaust gas stream.

According to the present invention in a second aspect, there is provided a combustion generator and an apparatus according to the first aspect of the invention in which exhaust gas from the generator flows to an apparatus inlet.

Suitably, the generator is an internal combustion engine.

Brief Description of the Drawings

The present invention will now be described, by way of example only, with reference to the drawings that follow; in which:

Figure 1 is a schematic partly sectional view of an apparatus for removing pollutants from a gas stream according to an embodiment of the present invention.

Figure 2 is a schematic perspective, partly cutaway view of the Figure 1 embodiment.

Figure 3 is an enlarged cross-sectional (longitudinally) view of the electrode holder of Figure 1.

Figure 4 is a schematic partly-sectional view of a second embodiment of the present invention.

Figure 5 is a schematic partly-sectional view of a third embodiment of the present invention.

Figure 6 is a schematic partly-sectional view of a fourth embodiment of the present invention.

Description of the Preferred Embodiments

Referring to Figure 1 of the drawings that follow, there is shown an apparatus 2 for diverting pollutants, especially particulates from gas streams. The apparatus 2 is mounted in a vehicle exhaust (not shown), typically in a silencer thereof, through which inflowing exhaust gas enters at 4 and exits at 6.

The apparatus 2 comprises an outer body 8, typically of sheet steel. Within outer body 8 there is defined a first expansion chamber 10 defined by internal wall 12 leading to a perforated elongate tubular field tube 14 defining a tube mounted to outer body 4 by internal walls 12 and 16.

The tube 14 comprises a tube inlet 18 in first expansion chamber 10 and a tube outlet 20 in a second expansion chamber 22 defined in part by internal wall 16. The tube 14 is circular cylindrical and its cross-sectional diameter decreases at a constant rate from the tube inlet 18 to the tube outlet 20. The tube 14 is perforated by a multiplicity of evenly sized and spaced circular holes from the tube inlet 18 to the intersection of tube 14 with internal wall 16. From internal wall 16 to tube outlet 20

the tube 14 is solid. A major proportion, around 80% of the tube 14 is comprised of holes in the perforated region thereof. The tube 14 is substantially porous to gas flow.

A third expansion chamber 24 is located about the perforated tube 14. Third expansion chamber 24 is defined by internal walls 12 and 16. A further gas flow path is provided from third expansion chamber 24 to second expansion chamber 22 via filter 26 fitted to an outlet 28 in internal wall 16 of third expansion chamber 24. The filter 26 is an electrically regenerative filter such as that available from 3M under part number SK-1739. The filter 26 is wired for electrical regeneration though, for simplicity, this is not shown.

Thus exhaust gas can pass to second expansion chamber 22 to apparatus outlet 6.

An electrode 30 is mounted at one end thereof by a ceramic electrode holder 32 and projects into tube 14 along the longitudinal axis thereof for part of the length of the perforated section of tube 14. Electrode 30 projects into the part of tube 14 in third expansion chamber 24. Electrode 30 is connected to a high voltage power supply 34 by connection means 36.

It is noted that two gas flow paths are provided between gas inlet 6 and gas outlet 8. First and second gas flow paths 38 and 40 respectively are indicated by respective lines and arrow heads. First flow path 38 follows the following route: inlet 4, first expansion chamber 10, tube 14, second expansion chamber 22 to outlet 6. Second flow path 40 follows the following route: inlet 4, first

expansion chamber 10, tube 14, third expansion chamber 24, filter 26,second expansion chamber 22 to outlet 6.

Figure 2 shows the apparatus 2 with the outer body 8 cut-away for clarity.

In use, the electrode 30 is charged to about 40kV negative polarity. When vehicle exhaust gas enters the tube 14, a substantial proportion of particulates are ionised as they pass the electrode 30. Charged particulates are attracted to the floating earth of perforated tube wall 14. The momentum of the particulates and the acceleration acquired from their attraction to tube 14 generally causes them to pass through the perforated wall of tube 14. It can be said that the particulates are diverted into a second gas flow path 40 separate from the first gas flow path 38. The filter 26 is in one of the gas flow paths only, here the second gas flow stream 40. Some of the exhaust gas exits tube outlet 20 following first flow path 38. However, a proportion of the exhaust gas follows second flow path 40 and helps convey the diverted particulates to filter 26. The exhaust gas then passes through filter 26 which collects particulates being conveyed to it by the exhaust gas.

Surprisingly, it has been found that there is very little build of a particulate on the perforated walls of tube 14 although the mechanism for this is not as yet fully understood.

Referring to Figure 3 of the drawings that follow, the electrode holder 32 comprises a one-piece ceramic with a longitudinal hole 42 therethrough, through which the

electrode 30 (not shown in Figure 3) is mounted. Electrode holder 32 includes a plurality (in this case three) of rebated conical protrusions 44a, 44b and 44c annularly about holder 32 to provide a tortuous path for current flow from electrode 30, that projects from end 46 of electrode holder 32, to earth, discouraging leakage.

The pollutant separation apparatus of this embodiment of the present invention has several advantages. First, there is little or no particulate build up along the main first flow path 38, thus very little of the particulates collected from the exhaust gas stream are subsequently flushed out through the exhaust. It is a recognised problem with proposed particulate collection systems that they often merely vent larger particulate agglomerates because after separation of the particulates from the gas flow stream they agglomerate and are subsequently flushed by passing gas.

Further, by separating the particulates from the main first gas flow stream 38 into the second gas flow stream 40, filtration of the particulates can be carried out to some extent "off-line" thus minimising back pressure. With existing systems and attempts at producing such systems, in practice as the particulate is filtered out if a filter is used, considerable back pressure develops reducing engine efficiency.

Referring to Figures 4-6 of the drawings that follow, three further embodiments of the present invention are shown, similar to the Figures 1-3 embodiment except as set out below. In Figures 4-6 like reference numerals are used for parts similar to the Figures 1-3 embodiment.

In the Figure 4 embodiment the tube 14 is of substantially constant diameter instead of tapering downstream. The Figure 4 embodiment may not perform as well as the Figures 1-3 embodiment, though it is still believed to be an improvement out known proposals and may be easier to manufacture.

In the Figure 5 embodiment the perforations in tube 14 are replaced by four equally spaced longitudinal slots, of which three are visible (at least in part) 46a, 46b and 46c. The slots 46 are porous to gas flow, but only provide gaps through tube 14 for a minor proportion thereof. Thus, particulates diverted towards tube 14 are far less likely to pass therethrough. As a result the more pollutant concentrated gas flow tends to be along first flow path 38 in which, in this embodiment, filter 26 is located.

Additionally in Figure 5, a catalytic converter 48 is located in the second flow path 40, though it is noted that the apparatus 2 can function upstream and/or downstream of a catalytic converter.

Figure 5 also shows a further modification in which a perforated section of tube 14 extends to the mounting arrangement 50 of electrode 30.

The embodiment of Figure 6 operates in a manner substantially similar to that of the Figure 5 embodiment, except that a perforated section 52 of tube 14 is provided for a minor proportion thereof.

Thus both the Figure 5 and 6 embodiments provide gas porous regions only for a minor portion of tube 14.

It is noted that there may be a plurality of apparatus as described above in a gas flow path, in series or in parallel.

Although preferred embodiment are described above in relation to the diversion of particulates from an exhaust gas flow stream, the apparatus can be used to divert particulates in other gas flow streams. However, it is believed currently that the present invention is of particular benefit when used in an internal combustion engine exhaust gas flow.

Instead of a d.c. voltage, high frequency a.c. may be usable.

Accordingly, embodiments of the present invention can divert particulates from a gas stream, the efficiency thereof being enhanced by providing a porous field tube, and with a particulate removal means, such as the filter described herein, can remove particulates from a gas stream.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.